

# **RICH Digitization & Reconstruction**

Fermilab Meeting, Nov 2002  
Sin Man Seun (Sharon)

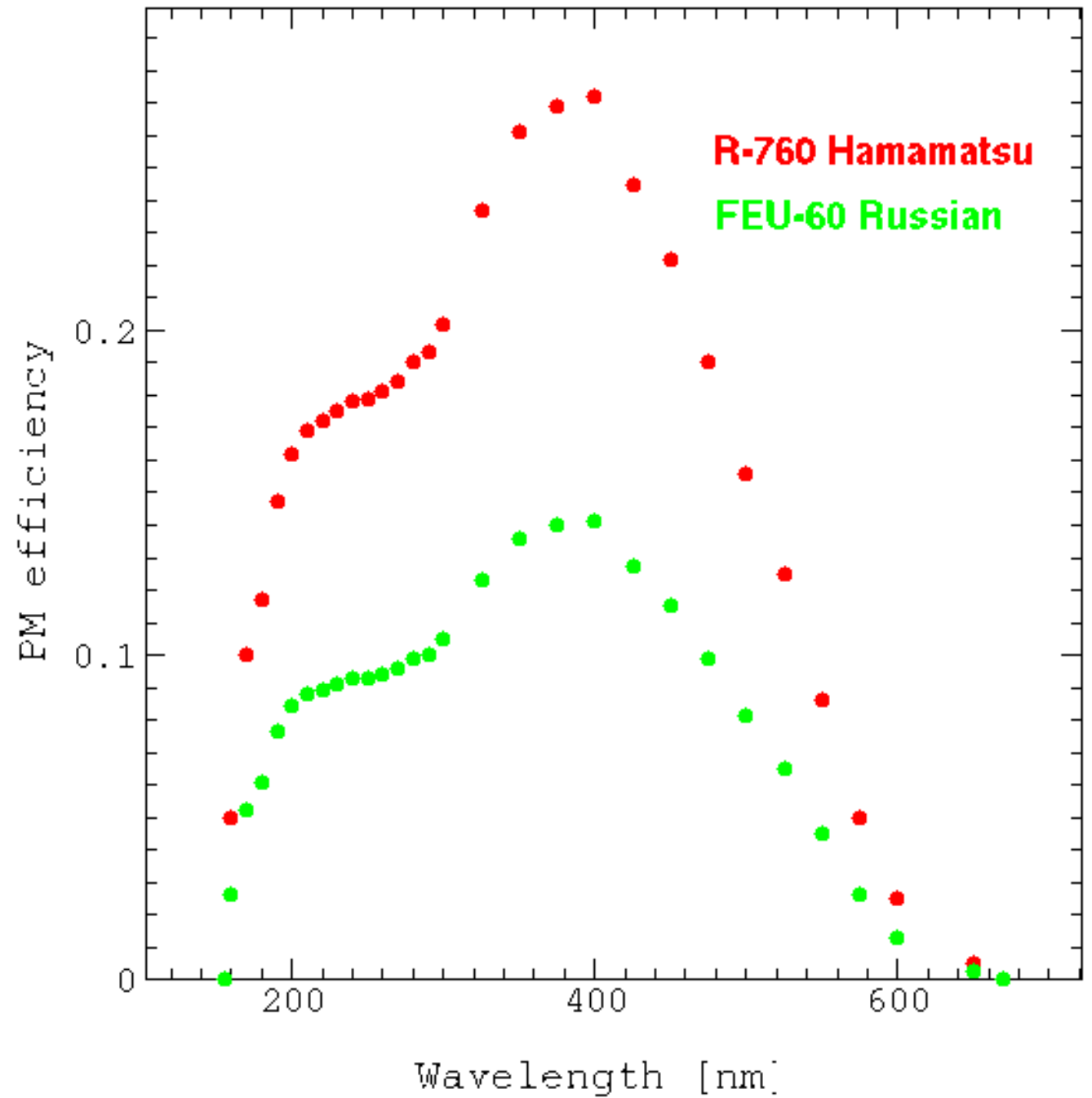
- Digitization Code
- Noise to Digits Study
- Ring Radii Study
- Reconstruction Algorithms
- Next Step

# Digitization

- Code: completed
  - Poisson distribution of noise
  - PMT efficiency (SELEX code)
- Digitization value stored: PMT number
- Need to do a precise calculation on the expected number of photons

# Digitization

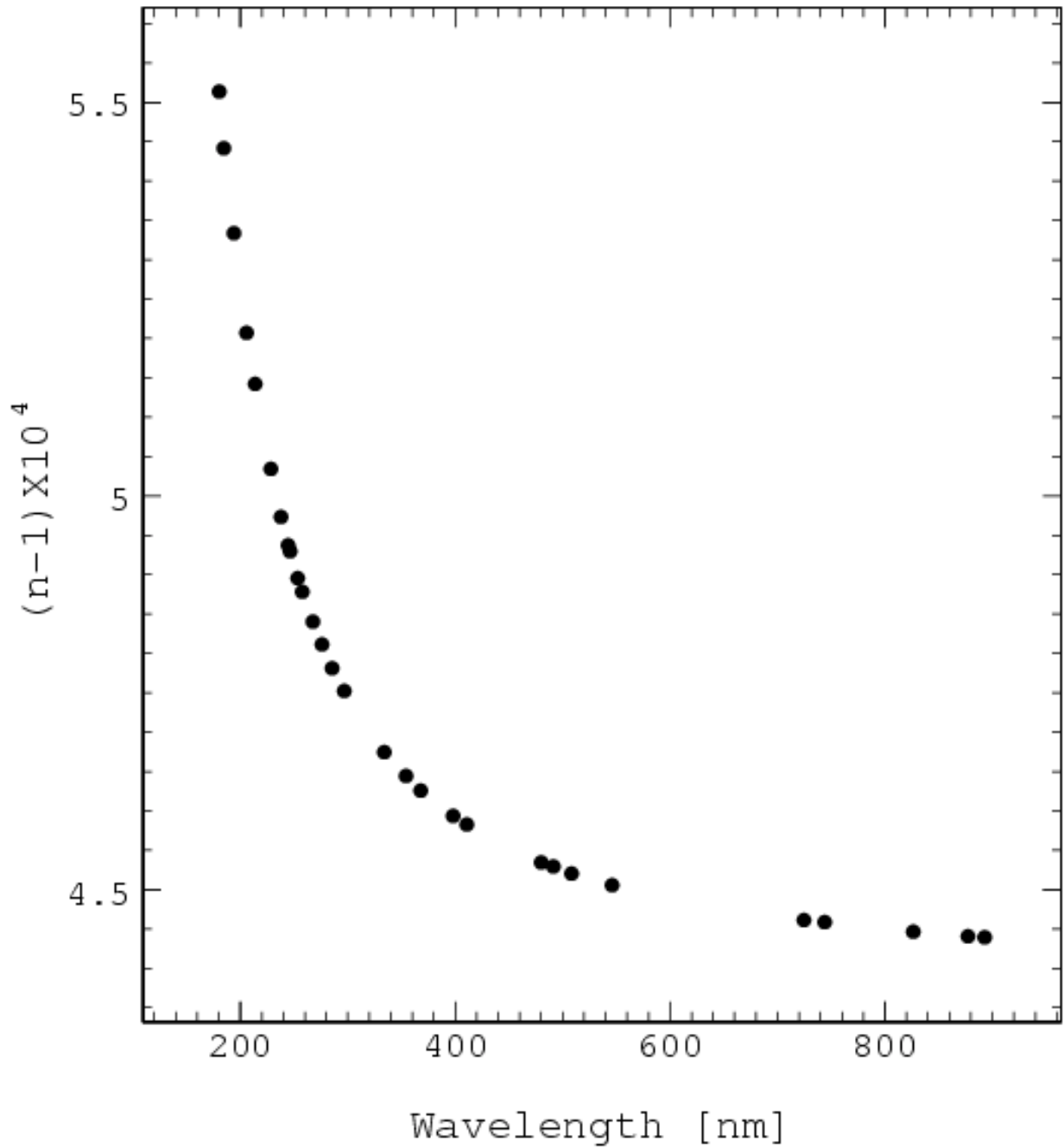
Function of PM efficiency



Source: SELEX code

# Digitization

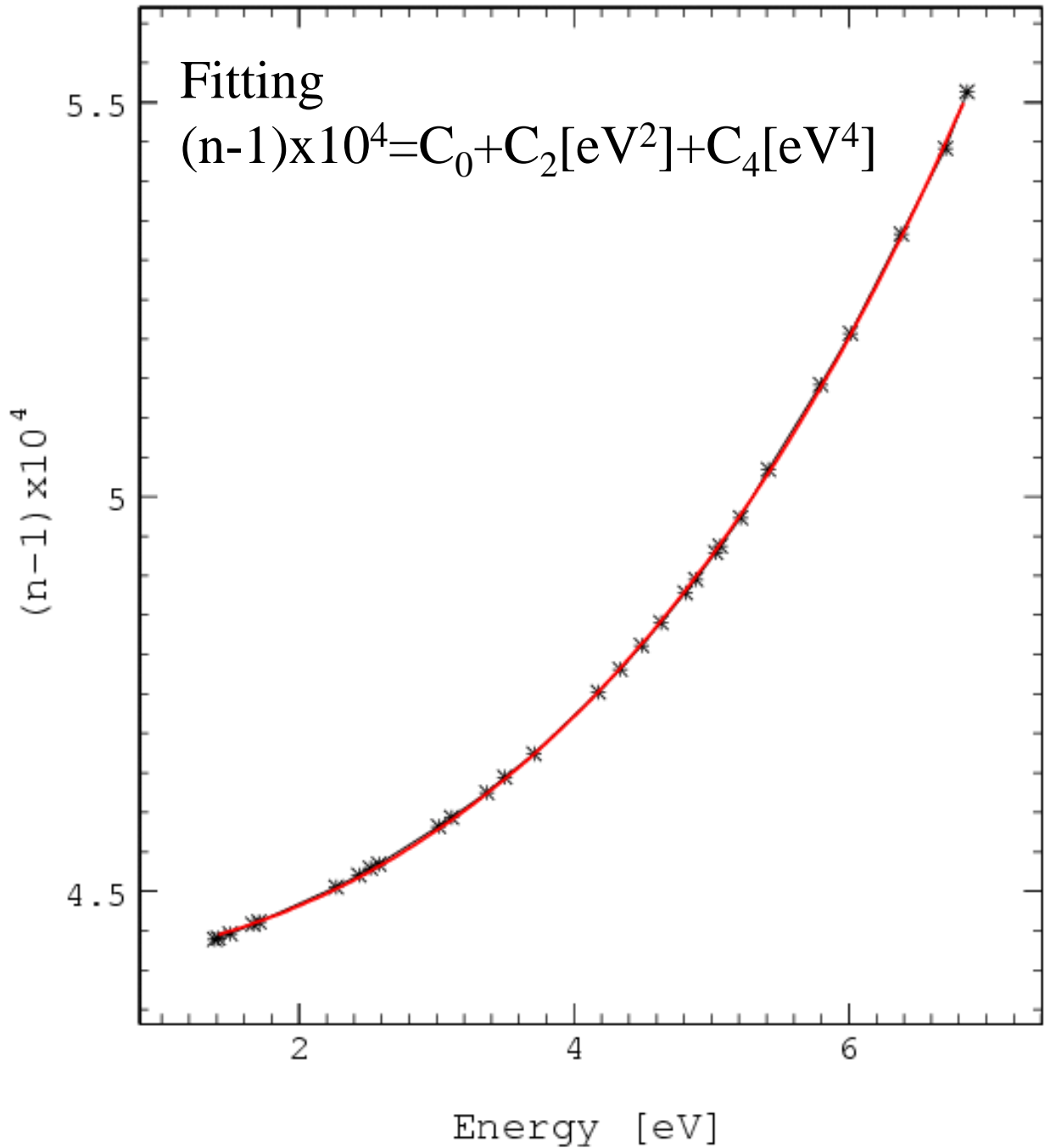
Index of refraction for CO<sub>2</sub>



Source: library book

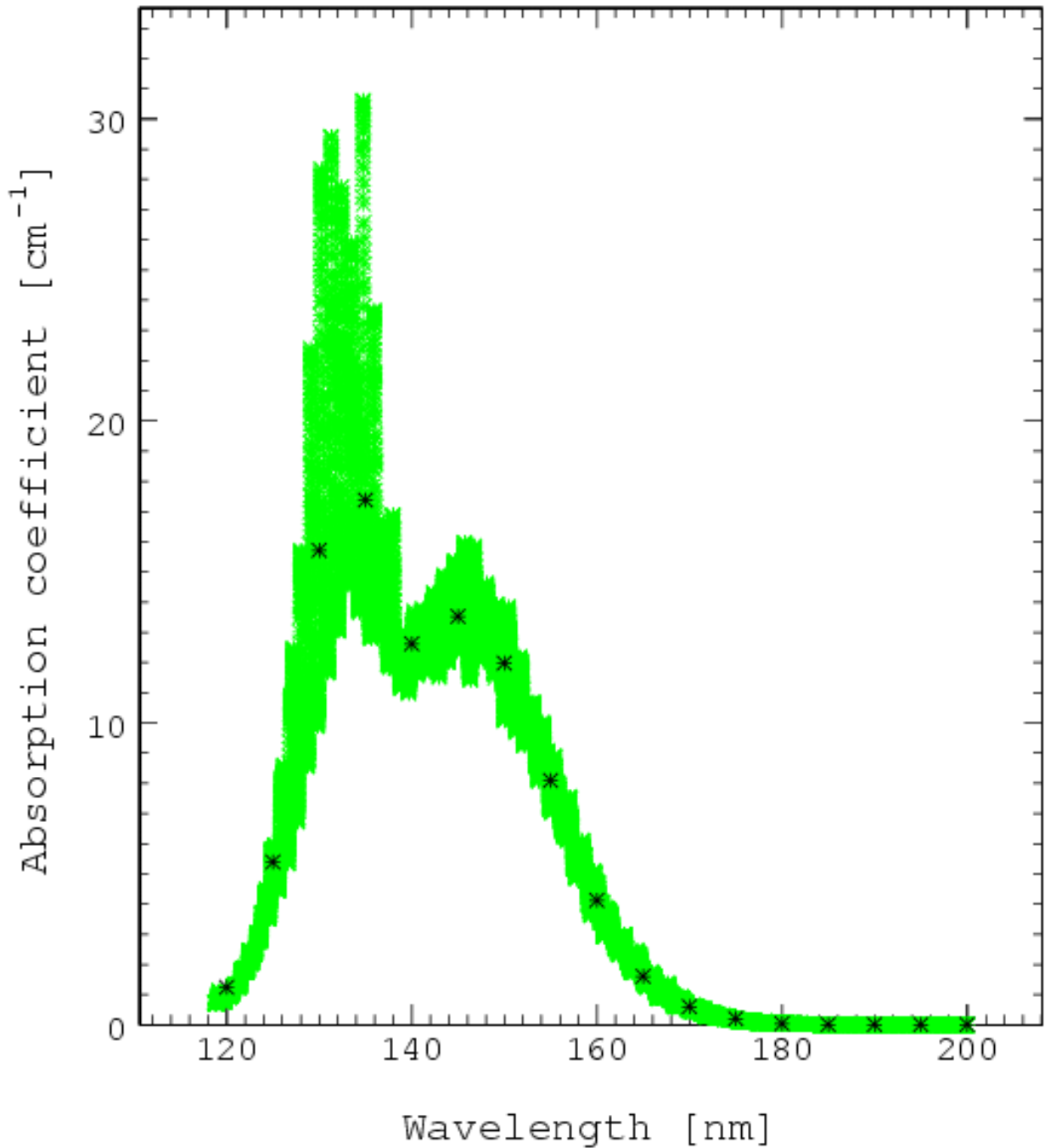
# Digitization

Index of refraction for CO<sub>2</sub>



# Digitization

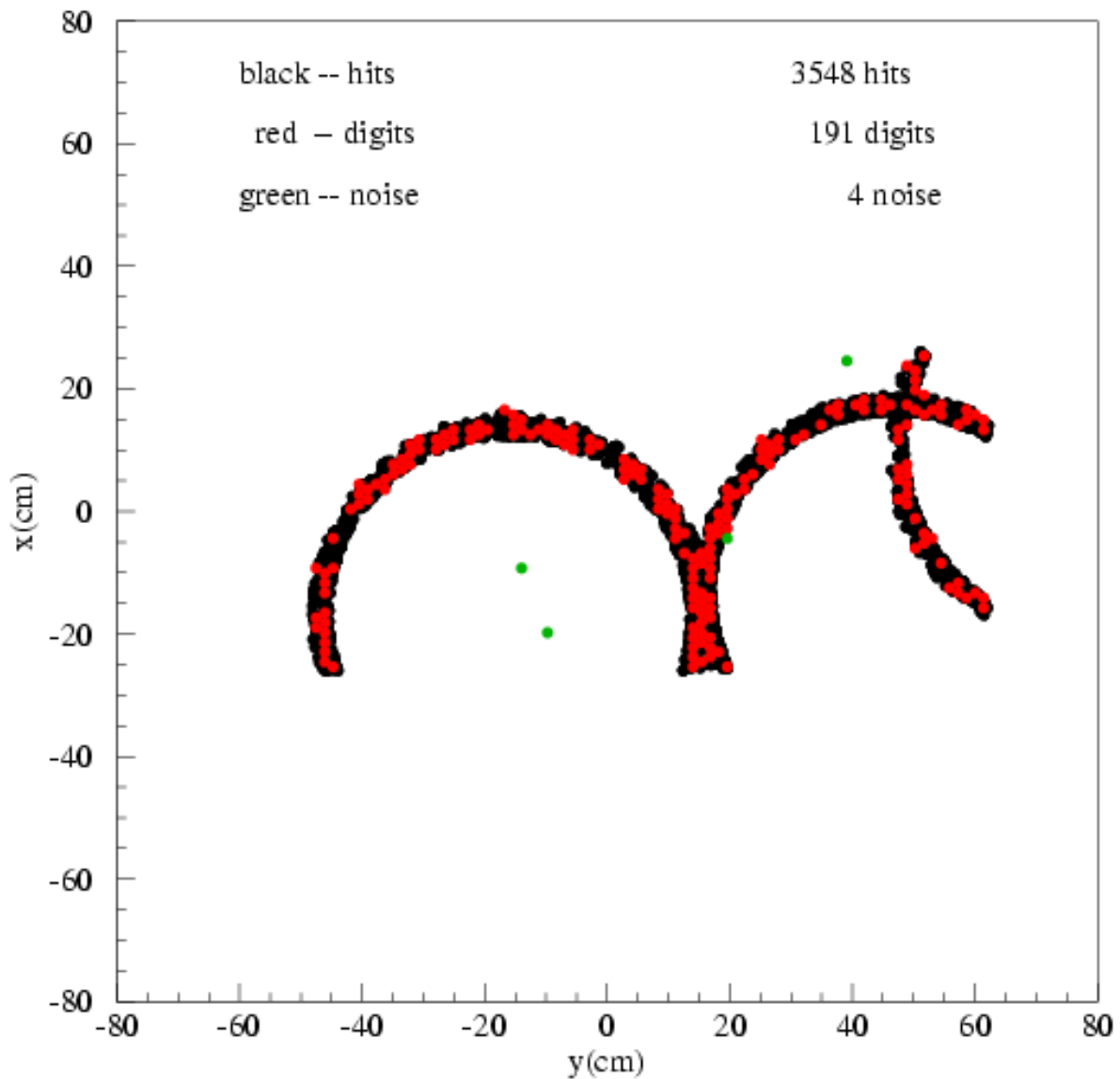
Absorption coefficient for CO<sub>2</sub>



Source: K. Yoshino, Harvard U

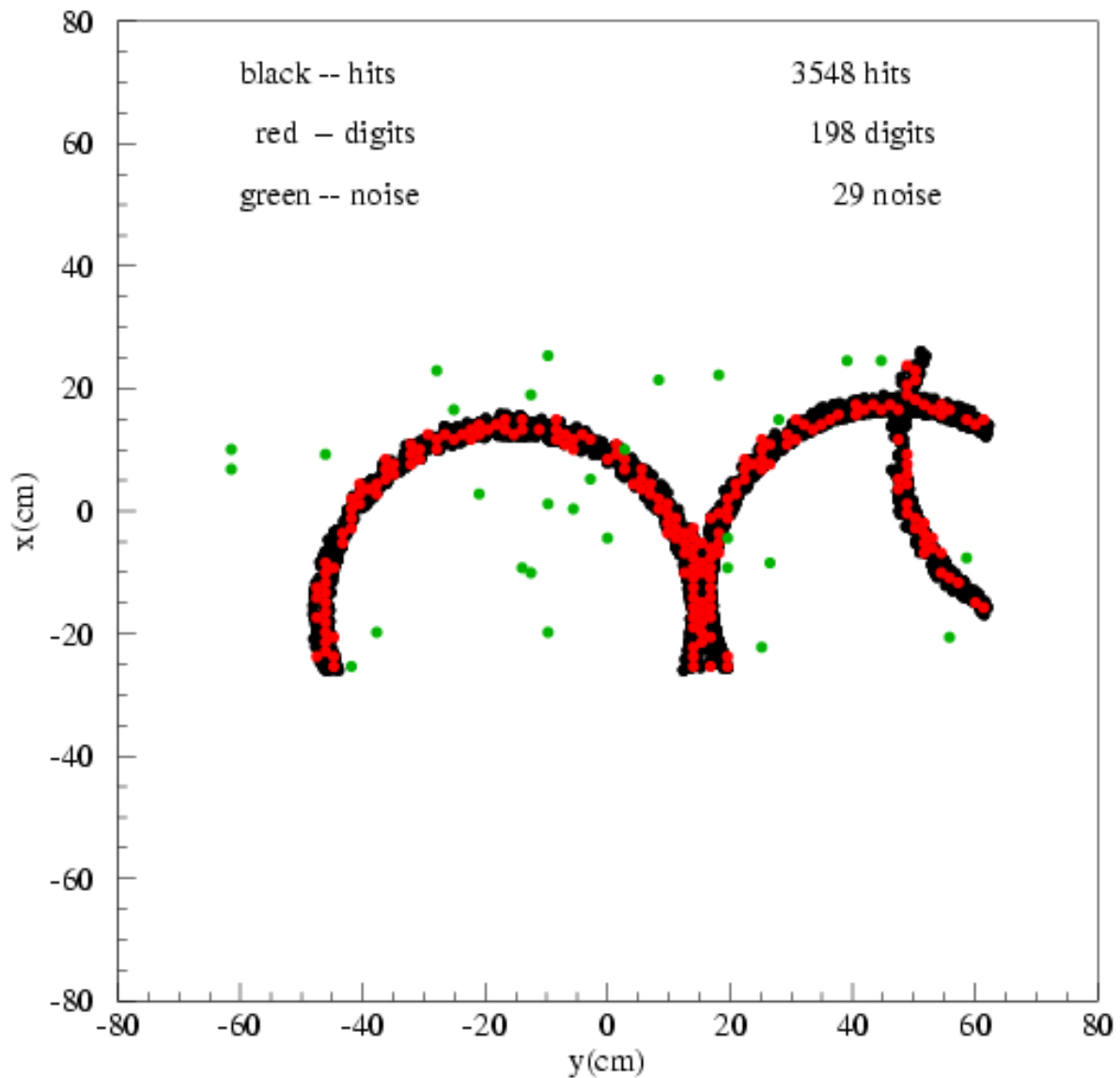
# Noise to Digits Study

Event display with time\_window=150ns



# Noise to Digits Study

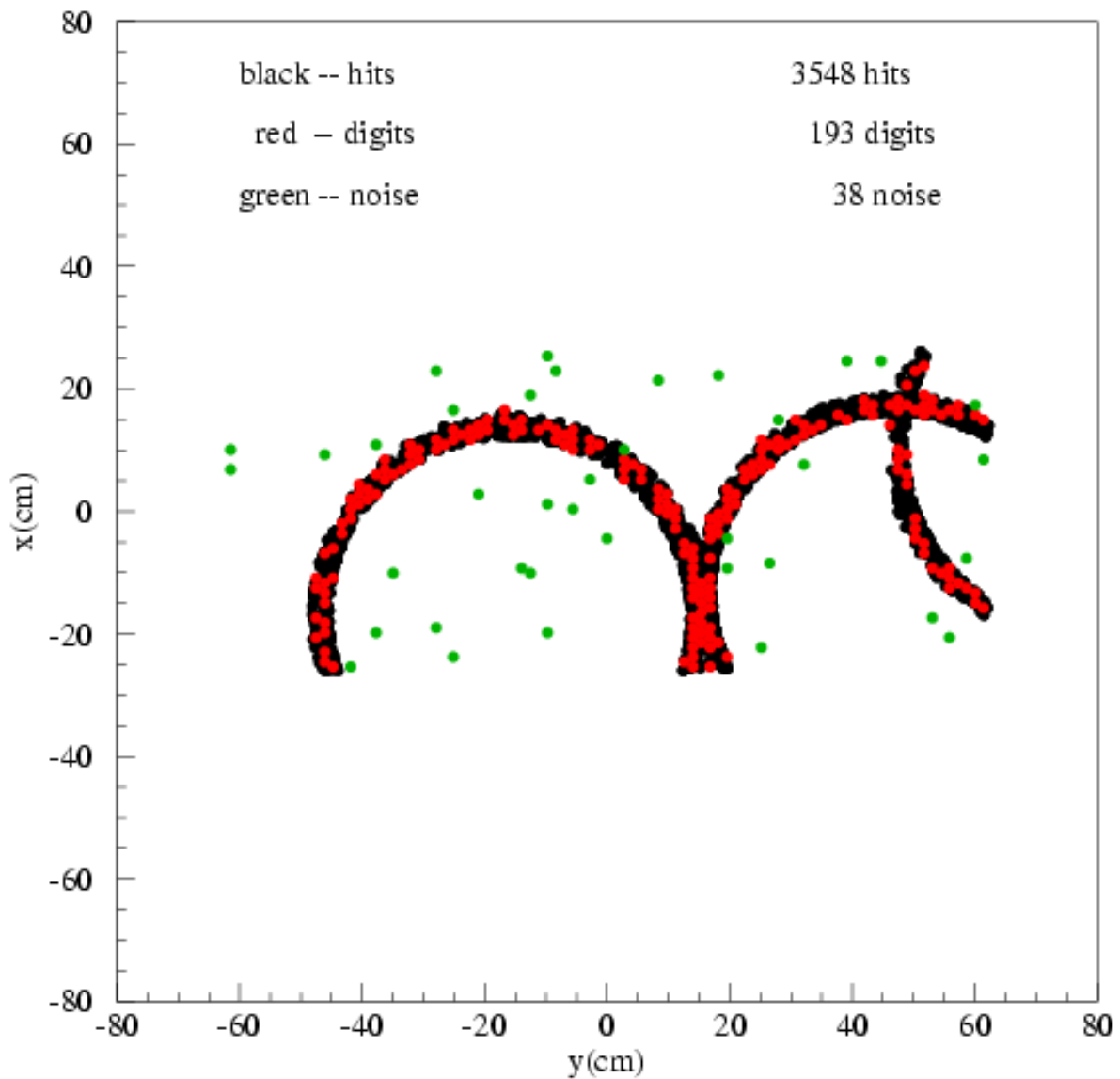
Event display with time\_window=250ns





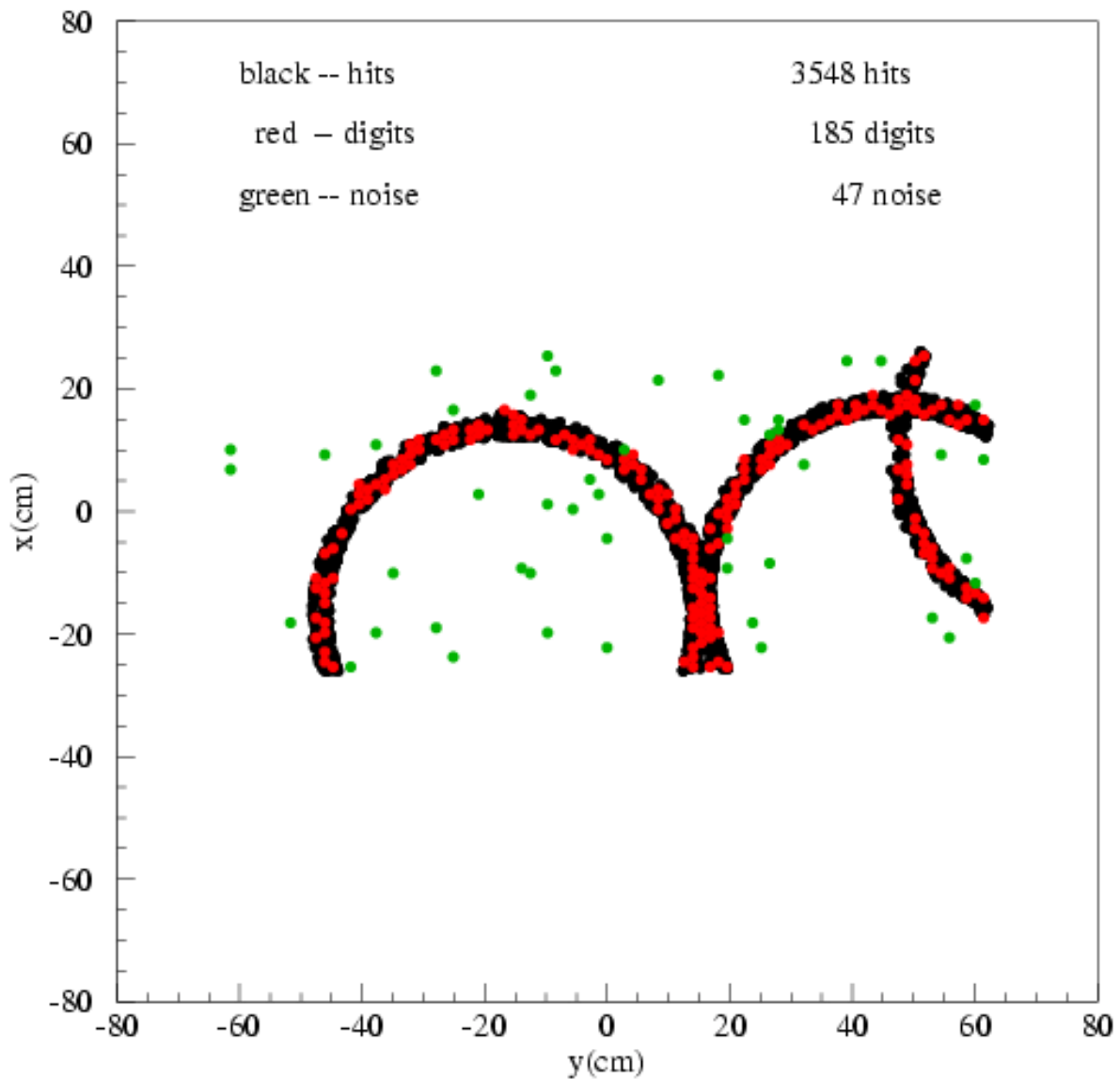
# Noise to Digits Study

Event display with time\_window=350ns



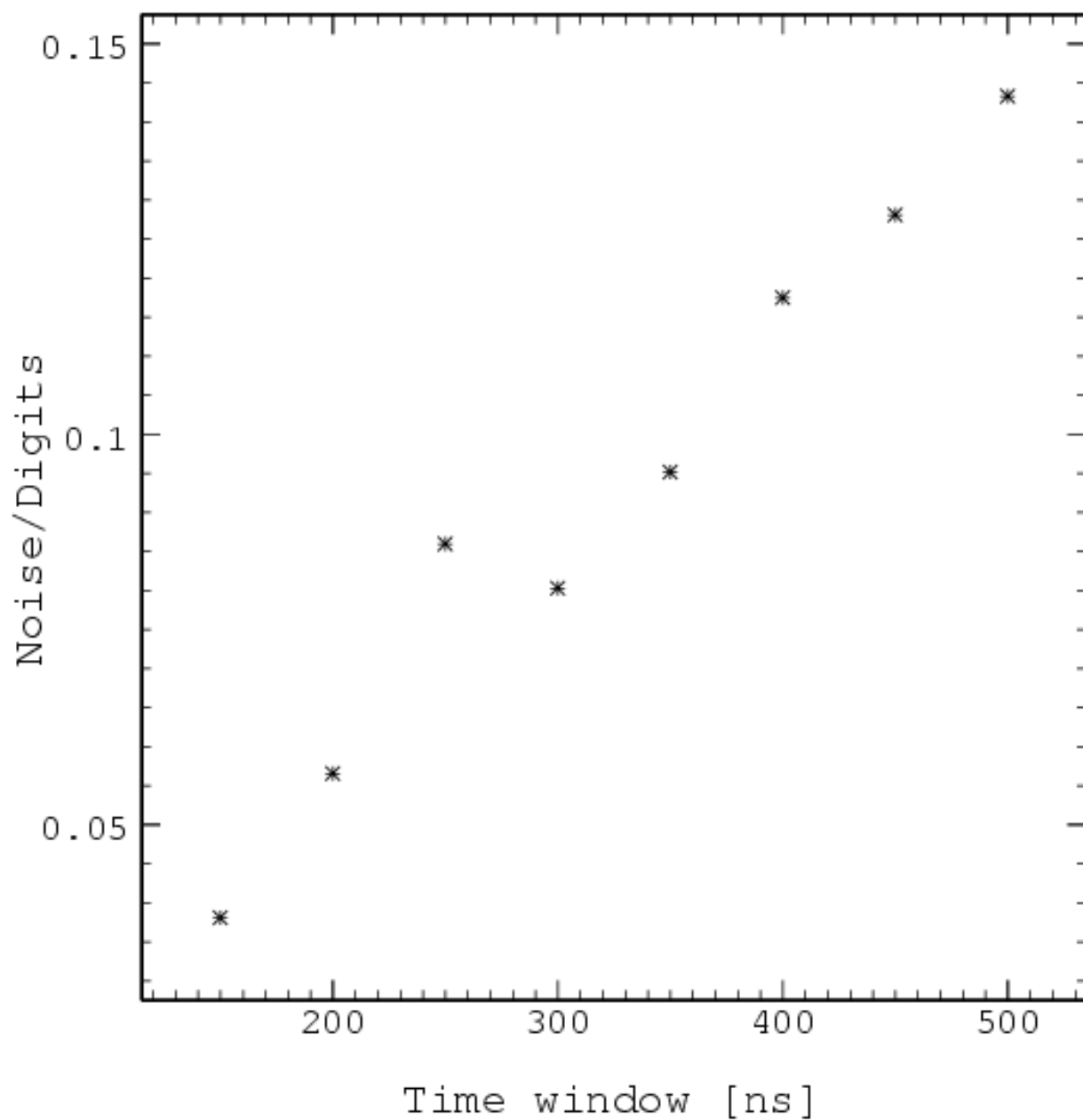
# Noise to Digits Study

Event display with time\_window=450ns



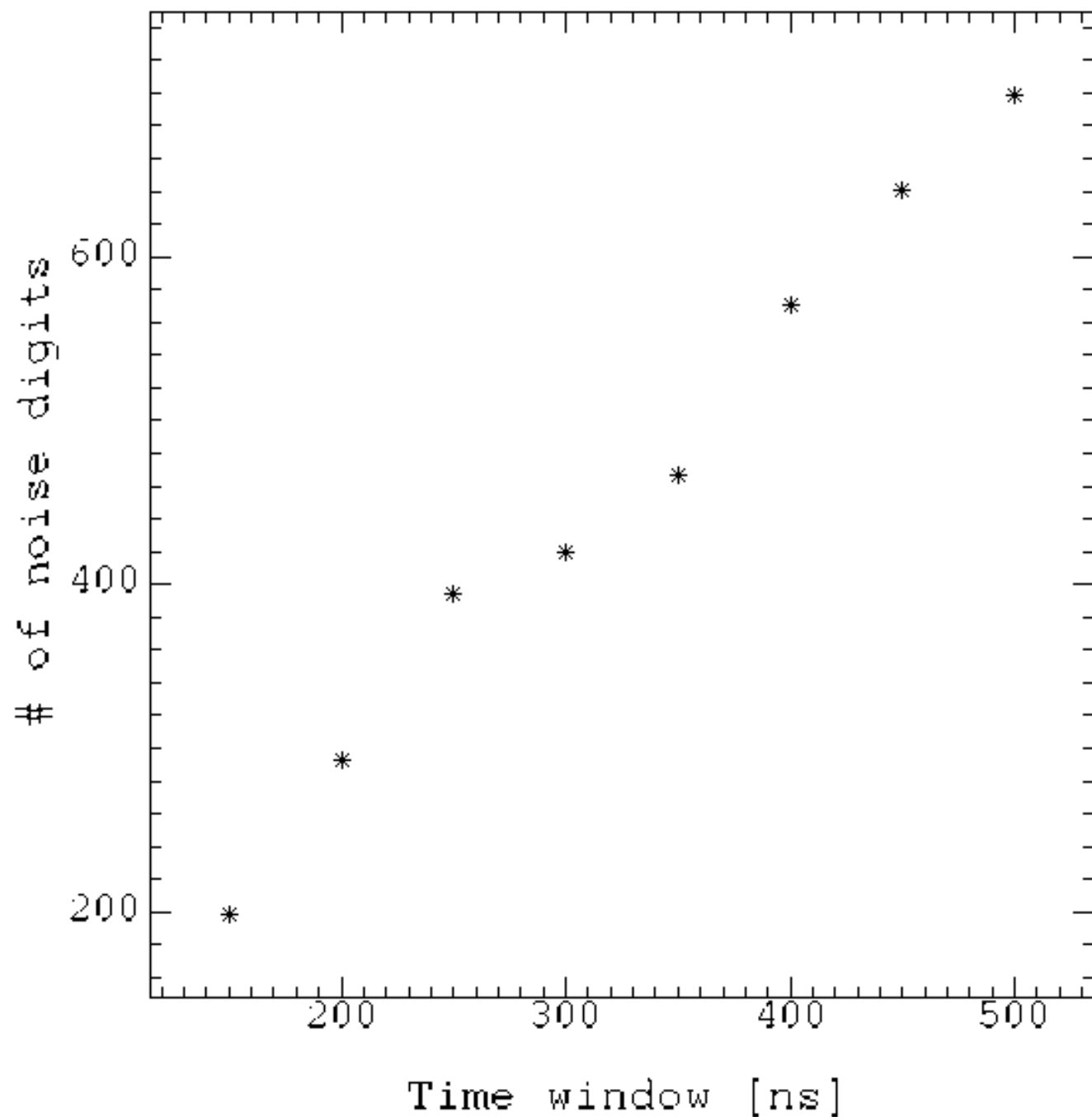
# Noise to Digits Study

Noise ratio of the PMTs (20 events)



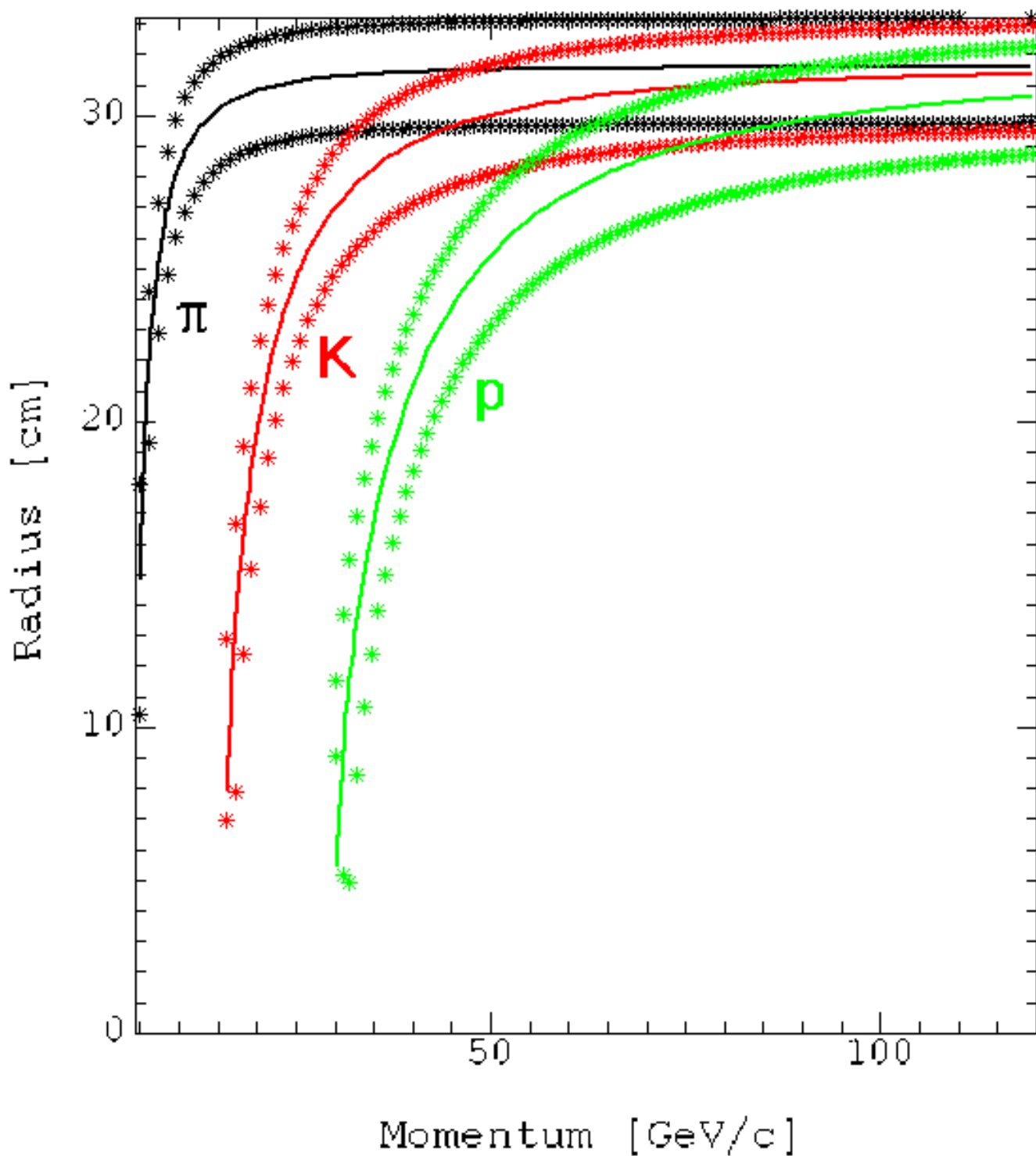
# Noise to Digits Study

Total noise of the PMTs (20 events)



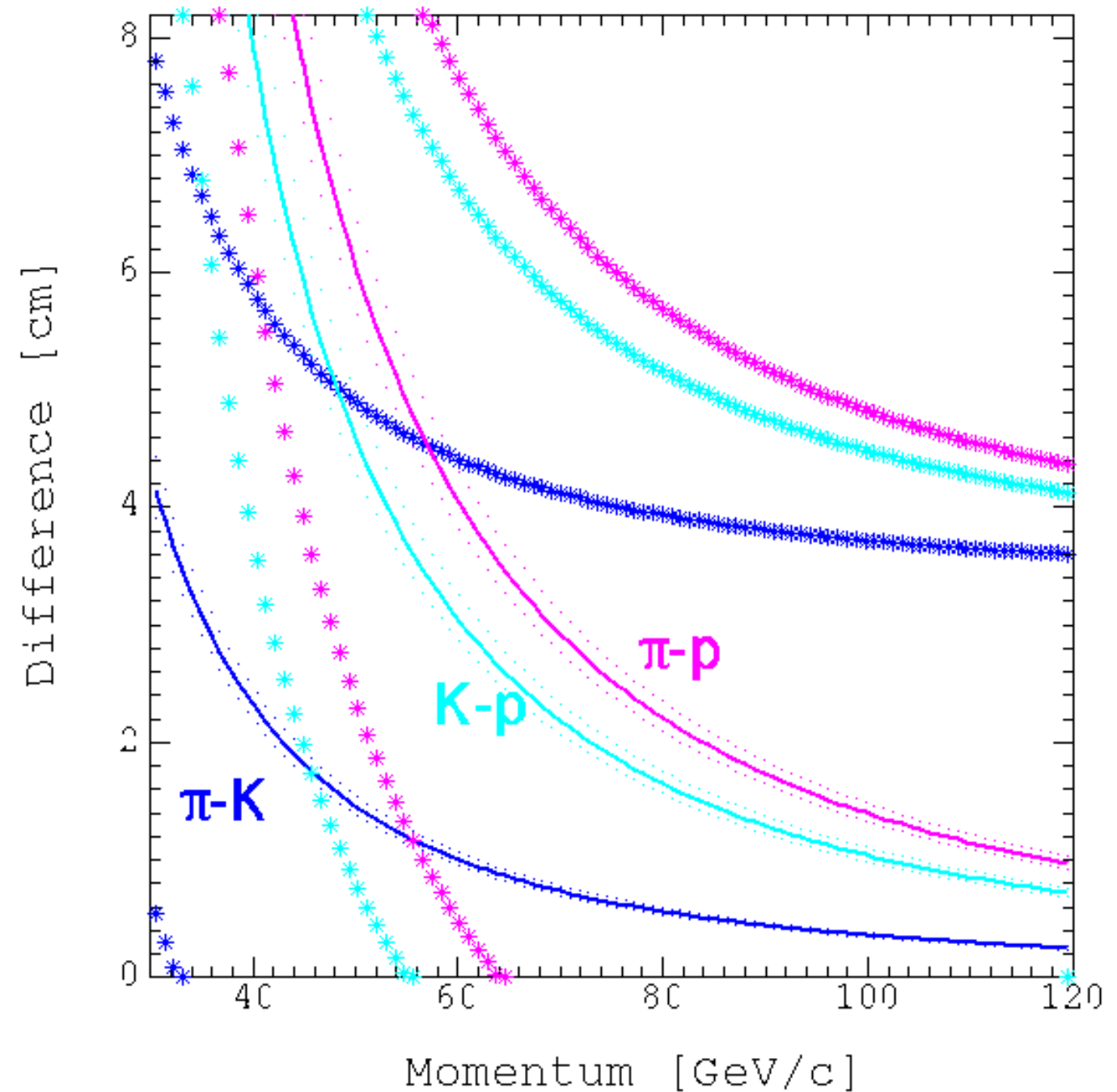
# Ring Radii Study

Ring radii for different particles with n variation



# Ring Radii Study

Ring radii difference for different particles with n variation



# Reconstruction Algorithms

- For single ring, one can

$$\chi^2 = \frac{\sum_i \left( \sqrt{(x_i - x_0)^2 + (y_i - y_0)^2} - r_0 \right)^2}{\sigma^2}$$

- WA89: maximum likelihood method
  - Given momentum and ring center  $\rightarrow$  predict rings radii for mass hypotheses  $\pi$ , K and p
  - Gaussian distribution for the signal

$$S_j(\vec{x}^{(i)}) = \frac{n_j}{2\pi R_j} \frac{1}{\sqrt{2\pi}\sigma} e^{-\frac{(r^{(i)} - R_j)^2}{2\sigma^2}}$$

- Poisson distribution

$$P(m \text{ photons}) = \frac{e^{-p_j} p_j^m}{m!}$$

where  $p_j = s_j + b$ ,  $s_j$  and  $b$  are the expected number of signal and background photons respectively in surface  $A$

- Likelihood function for hypothesis  $j$

$$L_j = P(m) \times \prod_{i=1}^m \left( \frac{S_j(\vec{x}^{(i)}) + B(\vec{x}^{(i)})}{s_j + b} \right)$$